PHYS-751

Advanced concepts in particle accelerators

Herr Werner Friedrich, Ischebeck Rasmus, Pieloni Tatiana

Cursus	Sem.	Type
Physics		Opt.

Language of teaching	English
Credits	4
Session	
Exam	Oral presentation
Workload	120h
Hours	**70**
Lecture	28
Exercises	14
Project	28
Number of positions	

Frequency

Every year

Remark

Next time: Spring

Summary

Accelerator physics covers a wide range of very exciting topics. This course presents basic physics ideas and the technologies underlying the workings of modern accelerators. An overview of the new ideas and challenges of the possible paths towards the next generation of accelerators will be given.

Content

Introduction to Accelerators: historical and conceptual steps pushing technology and energy reach:

- Accelerators at the energy frontier
- Applications in science, medicine and industry

Accelerator technology and single particle dynamics:

- Transverse beam dynamics
- Longitudinal beam dynamics
- Synchrotron radiation

Non-linear dynamics: phenomenology, tools and methods:

- Multipole expansion and term in Hamiltonians
- Wanted/unwanted non-linearities, tracking with non-linear elements, symplecticity
- Tune effects and Non-linear resonances
- Dynamic aperture
- Linear Normal Forms and analysis, Lie transformations

Collective effects in beam dynamics:

- Impedance and wakefields
- BeImpedance am instabilities in linear and circular accelerators
- Space charge
- Beam-beam effects, luminosity and colliders

- Free electron lasers

Advanced Acceleration concepts:

- Acceleration and technology today
- â#¢ Dielectric laser accelerators
- â#¢ Plasma wakefield accelerators
- â#¢ Laser interactions in free electron lasers and storage rings
- â#¢ Advanced concepts for the acceleration of protons and other ions.

Application of AI/ML to accelerator operation and design.
Visits to the CERN and PSI accelerator complex.

Note

Auditors should contact the lecturers before subscribing.
In-person class and exercises. Simulation project to design an accelerator.
Class limited to 40 participants.

Learning Prerequisites

Required courses

General basic courses of electromagnetism and classical mechanics

Expected student activities

to design a basic accelerator and to model and understand the dynamics of charged particles through the building blocks covered in the lectures (i.e. magnets, accelerating cavities, electron clouds, collisions)

Resources

Moodle Link

- https://go.epfl.ch/PHYS-751